MEAT SCRAPS VERSUS SOYBEAN PROTEINS AS A SUPPLEMENT TO CORN FOR GROWING CHICKS

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The proteins found in natural feed stuffs vary greatly in their nutritive value as well as in their solubility and in the proportions of the different amino acids which they are capable of yielding. The cereal grains contain most of the important amino acids but apparently in many cases in proportions unsuitable to promote growth and development. McCollum and his coworkers [1] have shown that the cereal grains, although they have a low biological value as compared to milk, have a remarkable value as supplementary sources of amino acids for certain vegetable proteins. It is thought that the value of corn proteins in producing growth has been somewhat underestimated. This may be due to the fact that one of the proteins (zein) which is usually present in a considerable amount, lacks two important amino acids (lysin and tryptophane), and the young animal fed on corn is incapable of appreciable growth on the only proteins remaining (glutelin, globulins, and albumins). Data obtained by R. H. Carr and coworkers [2] would seem to indicate that the amount of zein in mature corn is somewhat overestimated, and hence that the other proteins present were probably largely responsible for the consistent growth which was secured with chicks fed on corn containing less than 10 per cent proteins fortified with ash and with fat-soluble vitamines. The proteins of meats are credited with having a high value in producing growth, but their relative efficiency as compared with vegetable protein is not so well understood. The proteins of soybean are usually considered of excellent quality, [3] but their biological value is thought to be of the same order as that of corn and oats.

Most of the work done so far in measuring the biological value of proteins from various sources has been conducted on the rat or the pig, because these animals have many points of advantage for laboratory investigations. The growing chick has been used by some investigators,

[1] MCCOLLUM, E. V., SIMMONDS, N. and PARSONS, H. T. SUPPLEMENTARY RELATIONSHIPS BETWEEN THE PROTEINS OF CERTAIN SEEDS. *In* Jour. Biol. Chem., v. 37, no. 1, p. 155-178, 7 charts. 1918. Bibliography, p. 177-178.

[2] SPITZER, George, CARR, R. H., and EPPLE, W. F. SOFT CORN—ITS CHEMICAL COMPOSITION AND NITROGEN DISTRIBUTION. *In* Jour. Amer. Chem. Soc., v. 41, no. 8, p. 1212-1221. 1919.

[3] DANIELS, Amy L., and NICHOLS, Nell B. THE NUTRITIVE VALUE OF THE SOYBEAN. *In* Jour. Biol. Chem., v. 32, no. 1, p. 91-102. 1917.

notably Drummond,[1] who reports much difficulty in securing growth of the chicks in confinement. The chicks were troubled with "leg weakness" and "ruffled appearance," both of which defects were attributed to the lack of exercise in the open air. Osborne and Mendel [2] report partial success in raising chickens in confinement. Although they also report much difficulty with the chickens on account of "leg weakness," they were successful in raising several birds which seemed to develop quite normally. There are good reasons why it is desirable to use growing chicks in the laboratory to test the biological value of feeds. They represent an entirely different species from that of the rat or the pig, and it is hardly logical to translate the results secured on those animals to a species lower than mammals in the evolutionary scale. The ease with which it is possible to hatch eggs in an incubator and the rapid rate at which chicks grow and reach maturity, as well as the comparatively

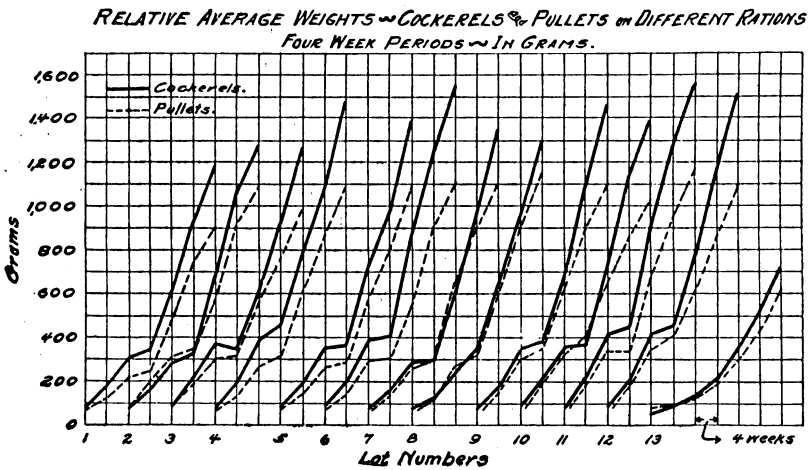


FIG. 1.—Graph showing the rate of growth of males and females in all lots.

small amount of feed required, are points in their favor for investigative work. The problem of securing normal growth in confinement has presented the greatest drawback to the successful use of chicks for this purpose. In the work here reported the writers had little difficulty with the disease known as "leg weakness" in the chicks, or with the other troubles usually experienced when rearing chicks in confinement, as reported in the literature. However, serious trouble was experienced from the eighth to twelfth week, when the chicks were developing a heavy growth of plumage. During this time 64 per cent of the total mortality occurred. The immediate cause of mortality was apparently excessive intestinal fermentation. After this critical stage was passed no further

[1] DRUMMOND, Jack Cecil. OBSERVATIONS UPON THE GROWTH OF YOUNG CHICKENS UNDER LABORATORY CONDITIONS. *In* Biochem. Jour., v. 10, no. 1, p. 77-88, 1 pl. 1916.

[2] OSBORNE, Thomas B., and MENDEL, Lafayette B. THE GROWTH OF CHICKENS IN CONFINEMENT. *In* Jour. Biol. Chem., v. 33, no. 3, p. 433-438, pl. 4-6. 1918.

trouble was experienced, and practically all the remaining chicks developed in a normal way. See figure 1.

OBJECT OF EXPERIMENT

The object of this experiment was to determine the value of corn protein in the growth of chicks when the proteins were fortified with sufficient ash and with fat-soluble vitamines, as compared with their value when supplemented by varying amounts of proteins derived from meat scraps or soybean meal or from these proteins in combination.

PLAN OF PROCEDURE

The stock used was 210-day-old White Leghorn chicks from the Purdue Poultry Farm. The chicks were hatched May 6 and divided into 14 lots of 15 chicks each. The initial individual weights of all the chicks were recorded on the sixth day, when all lots were given their respective rations tabulated in Table I. During the first 6 days all lots were given only granulated corn, grit, and water. Individual weights of the chicks were taken every 14 days after the initial weights were recorded. Each ration was "weighed back" on the same day the chicks were weighed in order to obtain the feed consumption for each period of 14 days. The growth period of the experiment was closed at the end of 26 weeks, but the pullets were kept for a longer time to note results of egg production.

The method of care and management of the chicks was that which is generally advocated for the successful rearing of chicks. Since the chicks were confined in pens 4 by 6 feet during the entire experiment, special effort was made to feed them so that they would be active as much of the time as possible and thereby avoid the evils of overfeeding.

Table I gives the rations, in part by weight, received by each lot.

In addition to these rations, each lot received water, grit, oyster shells, and about 75 gm. of the tops of sprouted oats. Oat straw was used for scratching litter. Lot 13, used as a control pen, received the basal ration only. The ash mixture was omitted from the ration of lot 2a as a control on the ash; otherwise this lot received the same ration as lot 2. Since there was no appreciable difference in the results obtained from these two lots, no further reference will be made to lot 2a. In each case the amount of protein concentrate (meat scraps or soybean meal) added to the basal ration is based upon a definite amount of crude protein from that source as shown in Table I. The amount of protein concentrate used depended upon its content of crude protein as determined by chemical analysis. Chemical analyses were made also of the other feeds which entered into the rations. The same feeds were used during the entire experiment.

TABLE I.—*Ration supplied to growing chicks during 26 weeks of experiment*

[Expressed in parts by weight]

Lot No.	Basal ration.						Meat scraps.	Soy-bean meal.	Nutri-tive ratio.
	Grain.		Mash.						
	Ground corn.	Corn meal.	Corn bran.	Ash.[a]	Char-coal.	Crude protein.			
1	50	35	15	3	3	5	8.86	.....	1:5.9
2	50	35	15	3	3	10	17.7	.....	1:4.4
2a	50	35	15	0	3	10	17.7	.....	1:4.4
3	50	35	15	3	3	15	26.6	.....	1:3.5
4	50	35	15	3	3	20	25.4	.....	1:2.9
5	50	35	15	3	3	5	.....	10.9	1:6.2
6	50	35	15	3	3	10	.....	21.8	1:4.8
7	50	35	15	3	3	15	.....	32.7	1:3.9
8	50	35	15	3	3	20	.....	43.6	1:3.4
9	50	35	15	3	3	5	4.4	54.5	1:6
10	50	35	15	3	3	10	8.86	10.9	1:4.5
11	50	35	15	3	3	15	13.3	16.4	1:3.7
12	50	35	15	3	3	20	17.7	21.8	1:3.2
13	50	35	15	3	3	.....	.....	.....	1:9

[a] The ash mixture used in the above rations was composed of the following ingredients, expressed in parts:

Bone ash	50
Calcium carbonate	14
Sodium chlorid	15
Dipotassium phosphate	10
Calcium lactate	5
Magnesium sulphate	3
Sulphur	2
Iron sulphate	1
	100

Table II shows the average total amount of feed and its protein content which was consumed in 13 periods of 14 days each and the ratio of the protein fed to the gain.

TABLE II.—*Ratio between average feed consumed and average gain in weight in 13 periods of 14 days each*

BASAL RATION PLUS MEAT SCRAPS

Lot No.	Feed consumed.	Protein in feed.	Protein consumed.	Average gain per 14-day period.	Ratio of protein in feed to gain.
	Gm.	*Per cent.*	*Gm.*	*Gm.*	
1	535	12.44	66.34	87.00	1:1.31
2	598	15.88	94.96	85.3	1:0.89
3	509	18.60	94.67	80.60	1:0.85
4	546	20.9	114.10	87.20	1:0.76
Average	547	.....	92.52	84.5	1:0.95

TABLE II. *Ratio between average feed consumed and average gain in weight in 13 periods of 14 days each*—Continued

BASAL RATION PLUS SOYBEAN MEAL

Lot. No.	Feed consumed.	Protein in feed.	Protein consumed.	Average gain per 14-day period.	Ratio of protein in feed to gain.
	Gm.	*Per cent.*	*Gm.*	*Gm.*	
5	530	12. 53	66. 40	89. 80	1:1. 35
6	631	15. 36	96. 92	104. 30	1:1. 08
7	533	17. 7	94. 34	97. 30	1:1. 03
8	551	19. 8	109. 10	90. 2	1:1. 83
Average	561	.....	91. 69	95. 30	1:1. 07

BASAL RATIO PLUS COMBINATION OF MEAT SCRAPS AND SOYBEAN MEAL

9	523	12. 64	66. 10	90. 9	1:1. 05
10	615	15. 6	95. 94	101. 20	1:1. 37
11	629	18. 11	113. 85	99. 80	0. 88
12	582	20. 31	118. 15	98. 00	1:0. 83
Average	587	.....	94. 60	97. 48	1:1. 03

BASAL RATIO ONLY

13	365	9. 12	33. 29	47. 92	1:1. 44

In this table the growth-promoting value of the protein is expressed numerically as suggested by Osborne and Mendel.[1] The table shows also that protein from meat scraps alone as a supplement to the basal ration in any amount was not equal to that from soybeans or from the combination of the two. Among the different lots (except the control lot 13) the average amount of feed consumed during the 13 periods of 14 days each did not vary greatly, ranging from 509 gm. for lot 2 to 631 gm. for lot 6. Hence it is quite important, from the standpoint of economy in feeding, to combine the amount and kind of protein with the basal ratio in the proportion which produces the best growth. In this instance the best results were shown by lot 6, which received 10 parts of protein from soybean meal. Next in order are lots 10, 11, and 12, which received 10, 15, and 20 parts protein, equally from meat scraps and soybean meal. Following these are the lots receiving protein from meat scraps. Plate 50 shows a cockerel and a pullet from lot 13, a cockerel from lot 10, and a pullet from lot 6.

[1] OSBORNE, Thomas B., MENDEL, Lafayette B., and FERRY, Edna L. A METHOD OF EXPRESSING NUMERICALLY THE GROWTH-PROMOTING VALUE OF PROTEINS. *In* Jour. Biol. Chem., v. 37, no. 2, p. 223-229. 1918.

The aim was to supply a sufficient amount of ash to each ration to meet all mineral requirements and so have but one variable protein running through the whole series of rations. The addition of ash to the rations containing meat scraps was probably unnecessary, but in order to secure uniformity the same amount was added to all.

Table III gives the percentage of nitrogen and ash in the feces at different periods of the experiment.

TABLE III.—*Distribution of feces nitrogen and ash at different periods*

Lot No.	Nitrogen and ash content of feces from chicks 4 weeks old.				Nitrogen and ash content of feces from chicks 20 weeks old.				Average total nitrogen in feces.[a]
	Total nitrogen.	Total nitrogen soluble in *N*/10 hydrochloric acid.	Total nitrogen insoluble in *N*/10 hydrochloric acid.	Ash.	Total nitrogen.	Total nitrogen soluble in *N*/10 hydrochloric acid.	Total nitrogen insoluble in *N*/10 hydrochloric acid.	Ash.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
BASAL RATION PLUS MEAT SCRAPS									
1	2.63	35.0	65.0	31.04	3.25	37.6	62.2	24.69	2.73
2	3.63	35.8	64.2	35.91	3.76	29.1	70.9	27.76	3.56
3	2.76	31.8	68.2	40.18	3.45	18.5	81.5	27.26	3.35
4	4.21	35.7	64.3	32.99	6.23	15.7	84.3	20.83	4.44
Average	3.31				4.17				3.52
BASAL RATION PLUS SOYBEAN MEAL									
5	2.46	35.1	64.9	28.94	3.33	25.2	76.8	18.44	2.74
6	2.72	35.9	64.1	28.49	4.59	19.1	80.9	20.62	3.62
7	3.05	26.4	73.6	31.49	5.61	16.9	83.1	17.77	4.49
8	2.63	25.1	74.9	44.55	7.23	10.8	89.2	19.00	4.42
Average	2.71				5.19				3.82
BASAL RATION PLUS COMBINATION OF MEAT SCRAPS AND SOYBEAN MEAL									
9	2.68	31.0	69.0	25.07	3.95	20.6	79.4	17.12	2.91
10	2.59	37.1	61.9	32.89	4.87	18.1	81.9	28.59	3.52
11	3.02	31.6	68.4	36.84	5.45	24.5	75.5	17.72	4.00
12	4.00	32.5	67.5	36.30	7.63	14.6	85.4	22.26	4.92
Average	3.07				5.48				3.84
BASAL RATION ONLY									
13	1.91	34.4	65.6	31.75	2.70	26.9	73.1	15.36	2.24

[a] Average total nitrogen is the average for the 4-, 8-, 16-, and 20-week periods.

The table may be summarized as follows:

Lot No.	Ration.	Average total feces nitrogen.	Increase in waste.
		Per cent.	*Per cent.*
13	Basal	2. 24	.....
1, 5, 9	Basal+5 parts protein	2. 79	24. 5
2, 6, 10	Basal+10 parts protein	3. 57	59. 4
3, 7, 11	Basal+15 parts protein	3. 95	76. 3
4, 8, 12	Basal+20 parts protein	4. 59	105. 0

The nitrogen soluble in *N/10* hydrochloric acid was considered to be ammonia, urea, and amino acid nitrogen. The nitrogen insoluble in N/*10* hydrochloric acid was considered to be uric acid and residual nitrogen.

The data in Table III indicate that in all lots receiving 5 parts of protein in addition to the basal ration, the excreta contained an average of 2.79 per cent nitrogen; in lots receiving 10 parts protein, they contained an average of 3.57 per cent; in lots receiving 15 parts, they contained an average of 3.95 per cent; in lots receiving 20 parts protein, they contained an average of 4.59 per cent; whereas in the lot receiving the basal ration only, they contained an average of 2.24 per cent nitrogen. This last figure was taken as maintenance nitrogen excretion. Since the feces in lots receiving 5 parts protein in addition to maintenance contained 2.79 per cent nitrogen, it was computed that the waste in excretion was 24.5 per cent greater than when the basal ration alone was fed. In the same manner 59.4 per cent more feces nitrogen was obtained for lots receiving 10 parts protein, 76.3 per cent more for lots receiving 15 parts, and 105 per cent more for lots receiving 20 parts. In brief, the greatest gain in weight was made with the least necessary nitrogen loss in feces when the basal ration was supplemented with 10 parts of protein.

It will be noted in Table III that the ash content of the feces collected when chicks were 4 weeks old and growth was most rapid was much greater for all lots than that of the samples collected when the chicks were 20 weeks old and growth was less rapid and maintenance requirements were greater. The excretion of nitrogen was very constant for all lots receiving the same amount of protein; and since the protein consumed increased by 5 parts in four successive rations, the average increases over control lot 13 were 2.79, 3.57, 3.95, and 4.59 per cent, respectively, for each addition of 5 parts of protein to the basal ration. Thus it would appear that there was no economy in nitrogen excretion at the point where the gain was most efficient (the addition of 10 parts protein), though such an economy might have been expected. Table III also shows that a 2-gm. sample of feces of any nitrogen content contained nearly the same weight of *N/10* acid-soluble nitrogen (ammonia,

urea, and amino acids) regardless of the total weight of nitrogen in the sample, and that only the uric acid, etc., increased in amount as more protein was fed.

SUMMARY

In conclusion, it would seem that it is possible to secure nearly normal growth of chicks when raising them in confinement, and that this method has many points of advantage as a means of measuring the biological value of feeds for chickens.

These results indicate that there is a wide range in the amount of protein which may be fed with little difference in results except in economy in feed consumption.

When the basal ration was supplemented with varying amounts of protein from meat scraps, soybean meal, or combination of the two, it is shown that an addition of 10 parts of protein from soybean meal gave the best growth. The next best gains came from 10, 15, and 20 parts of protein from the combination of soybean meal and meat scraps. All the meat scraps rations were found to be somewhat inferior to those of the soybean meal or the combination.

The amount of nitrogen present in the feces as ammonia, urea, or amino acids (soluble in *N*/10 hydrochloric acid) was nearly constant regardless of the total nitrogen present in any sample, the remainder of the nitrogen present being due largely to the uric acid. The amount of excreted nitrogen was dependent on the amount of the protein consumed and increased proportionately.

The data which have been presented tend to show that chicks are capable of greater utilization of soybean meal protein than are mammals, with which nearly all previous nutritional work has been done.

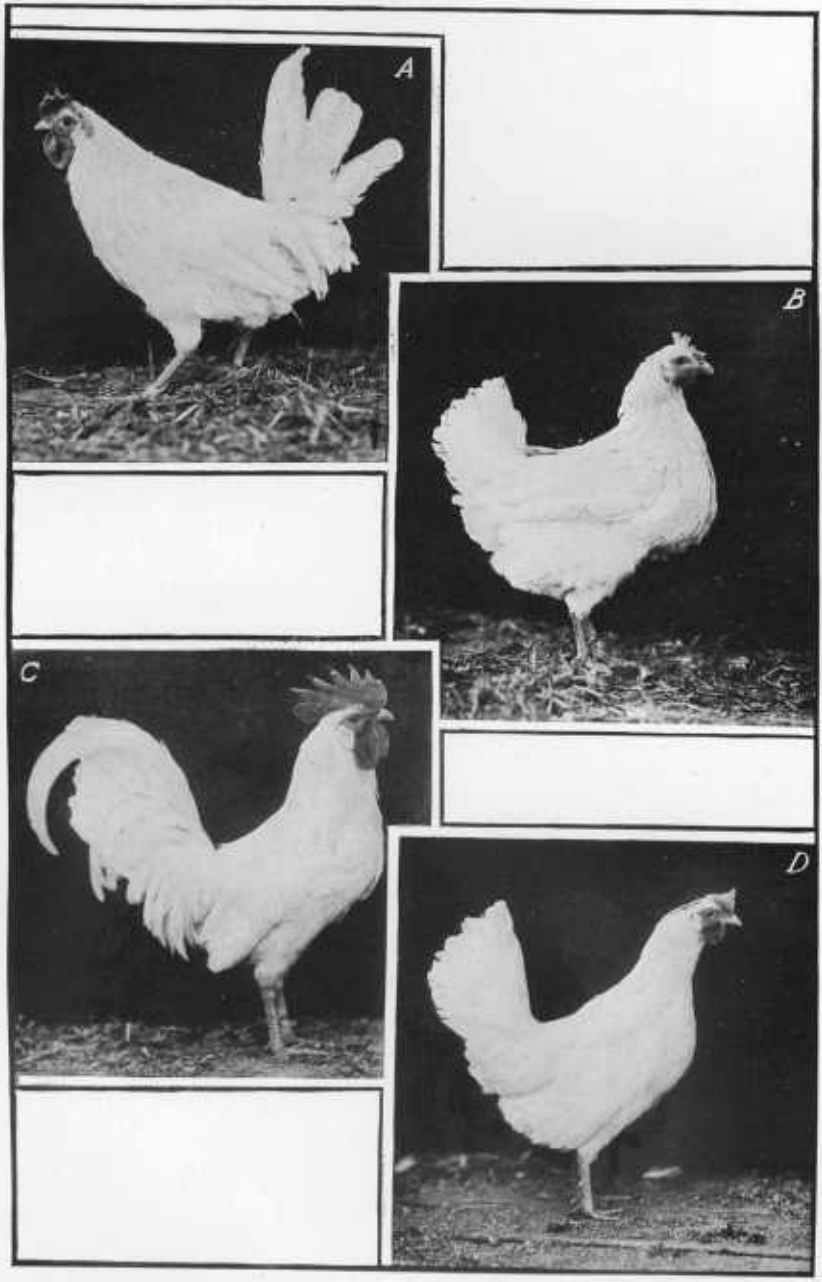
PLATE 50

A.—Cockerel No. 43, lot 13, fed on basal ration only. Weight, 710 gm. In perfect health but slow of growth.

B.—Pullet No. 44, lot 13, fed on basal ration only. Weight, 705 gm. Feathers not mature. Bird growing slowly but naturally, and gradually approaching maturity.

C.—Cockerel No. 54, lot 10, fed on basal ration plus five parts meat scraps protein and 5 parts soybean meal protein. Weight, 1,620 gm. Bird vigorous and normal in every respect.

D.—Pullet No. 82, lot 6, fed on basal ration plus 10 parts soybean meal protein. Weight, 1,295 gm. Bird vigorous, laying, and normal in every way.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